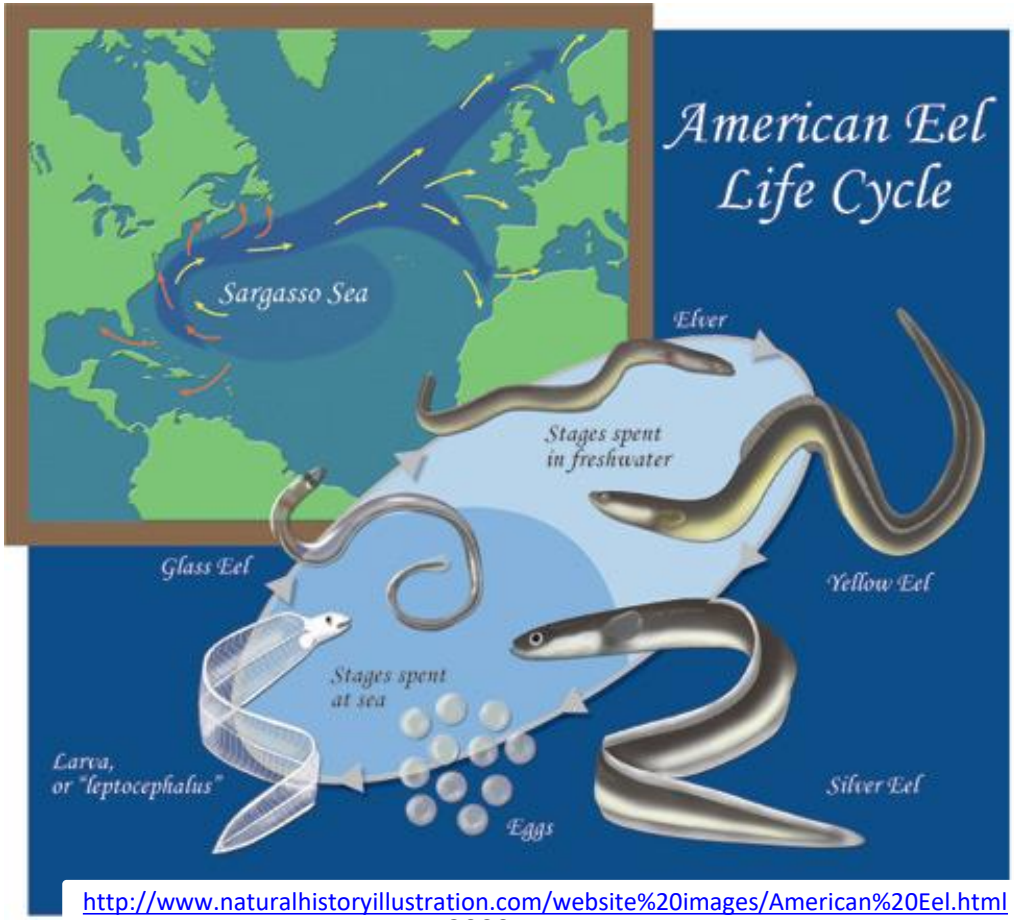
Fishes of Texas Project (fishesoftexas.org) | Texas Natural History Collection

American Eels in Texas – a review of what is known, what is being done to learn more, and how you can help

Dean A. Hendrickson (UT Austin, Biodiversity Collections (Texas Natural History Collections) and Fishes of Texas Project staff, in collaboration with Texas Parks and Wildlife Department



http://www.naturalhistoryillustration.com/website%20images/American%20Eel.html
(*Natural History* Magazine, **Nov. 2009**)

FISHES OF Texas

TEXAS PARKS & WILDLIFE

A Virtual Museum on the State's Fish Biodiversity

Hendrickson, Dean A., and Adam E. Cohen. 2015. "Fishes of Texas Project Database (Version 2.0)" doi:10.17603/C3WC70.

The "classical" life history of *Anguilla rostrata* – catadromous; reproduces in Sargasso Sea; 400,000 - 20 million eggs/female; larvae (leptocephali) marine; glass eels enter estuaries & move upstream becoming elvers; yellow eels (immature) live many years in freshwater and mature into silver eels that return to Sargasso to spawn/die

EVOLUTIONARY HISTORY AND DIVERSITY OF EELS

Order Anguilliformes – Eels - Anguilla is Latin for eel. First fossils ~ 80 mya (million years ago). All are elongate snake-like fishes using anguilliform (multiple S-like bends in body at any time) mode of swimming. Leptocephalus larvae are characteristic. Diverse (800 species). Global distribution. Most species strictly marine, but some use freshwater too.

Family Anguillidae – "Freshwater Eels" - ~20 species. First fossils ~15 mya. Worldwide. Usually catadromous (live in freshwater but spawn in marine waters)

Genus *Anguilla* – 18-19 species. Including extremely important and globally valuable food fishes

Species

- ***Anguilla rostrata*** - American Eel – what we're talking about today
- ***Anguilla anguilla*** – European Eel
- ***Anguilla japonica*** - Japanese Eel – the original Unagi.

And more, but these three share a common history of being very well studied and having intense interactions with humans, who have long loved to eat them.

American eel distribution - USGS 2015

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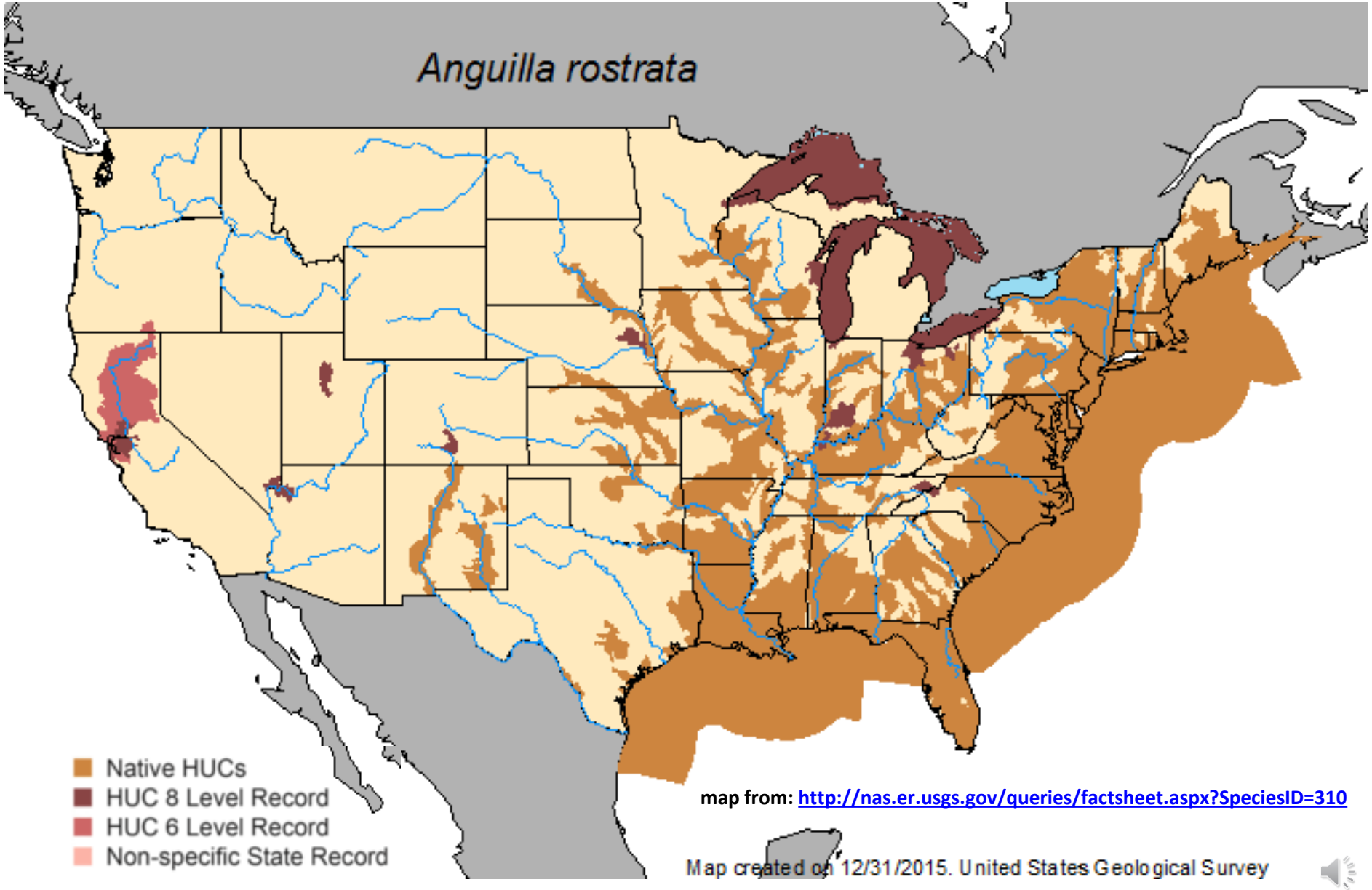

American eel adult distribution in U.S.- NatureServe 2010

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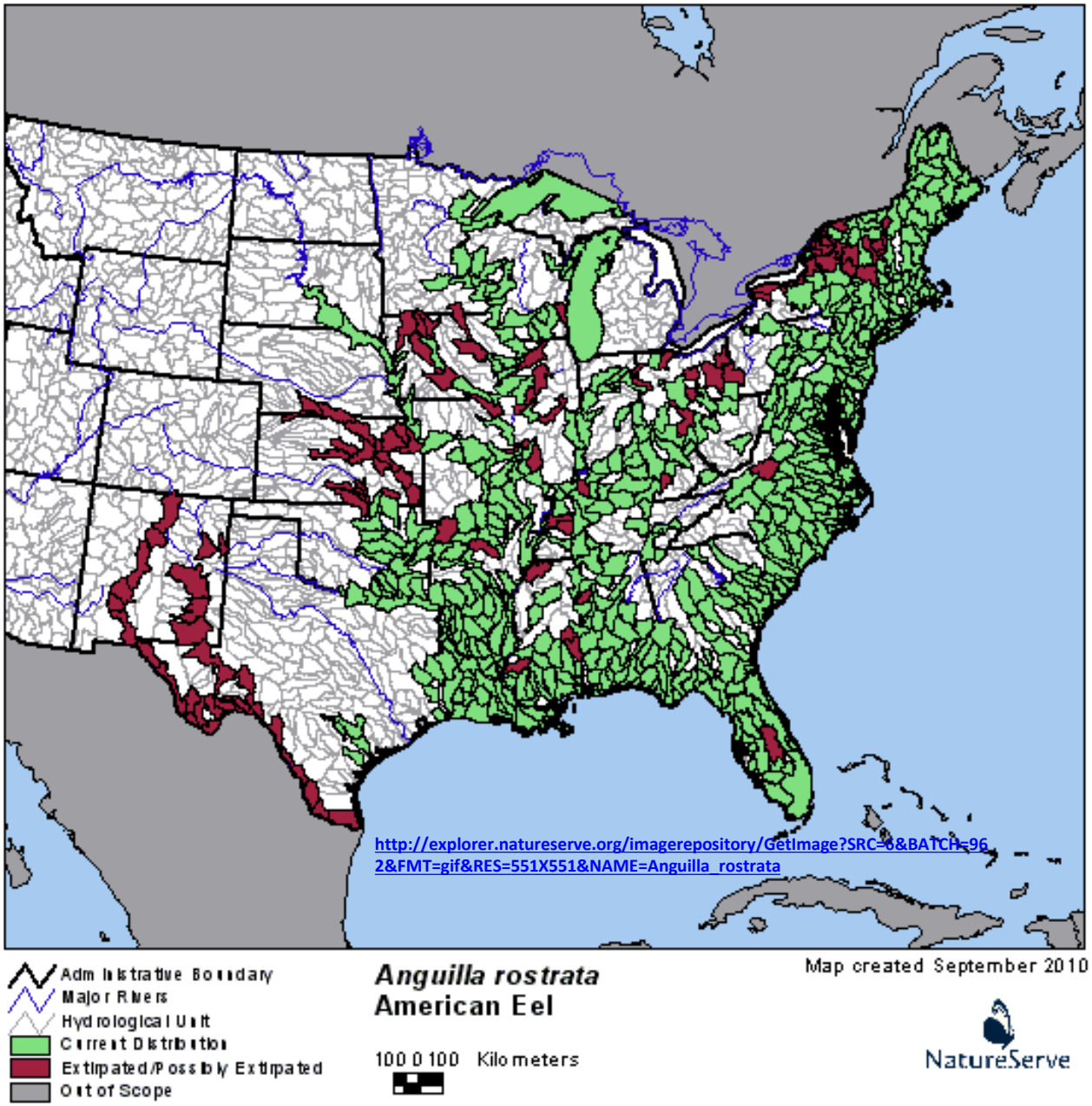

Prominent and authoritative sources of biodiversity data have long lacked data for Texas eels.

TX Comptroller vs FoTX

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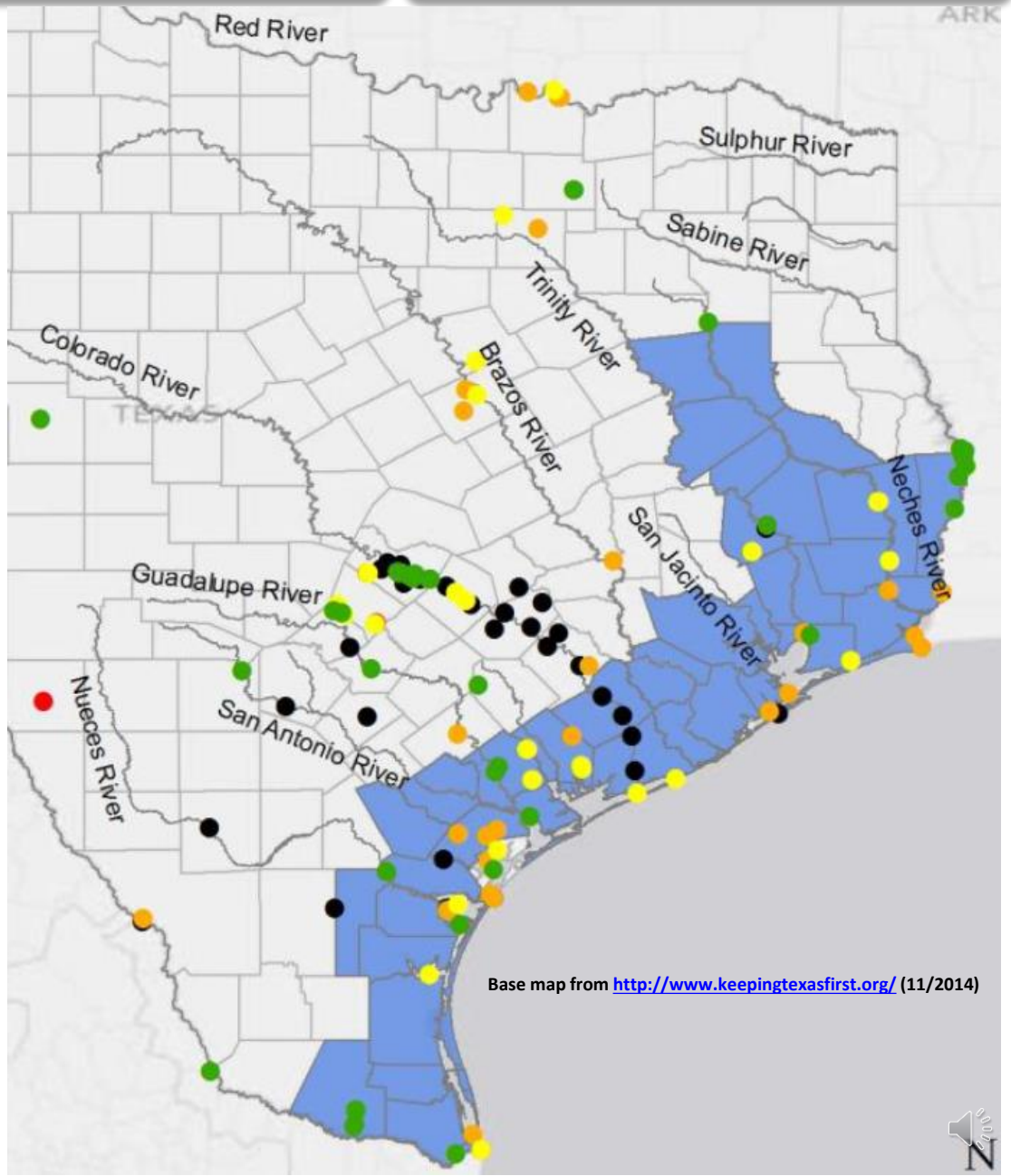
Texas Comptroller determined economic impacts related to listing of the eel as endangered would be restricted mostly to lower parts of rivers (blue counties)

Data we compiled showed many recent occurrences far upstream of that in most Texas rivers.

Only a few papers have ever been published on Texas eels.

- **1964 – 1990**
- **1991 – present**

others older or unknown



Eel data mining results – Texas details

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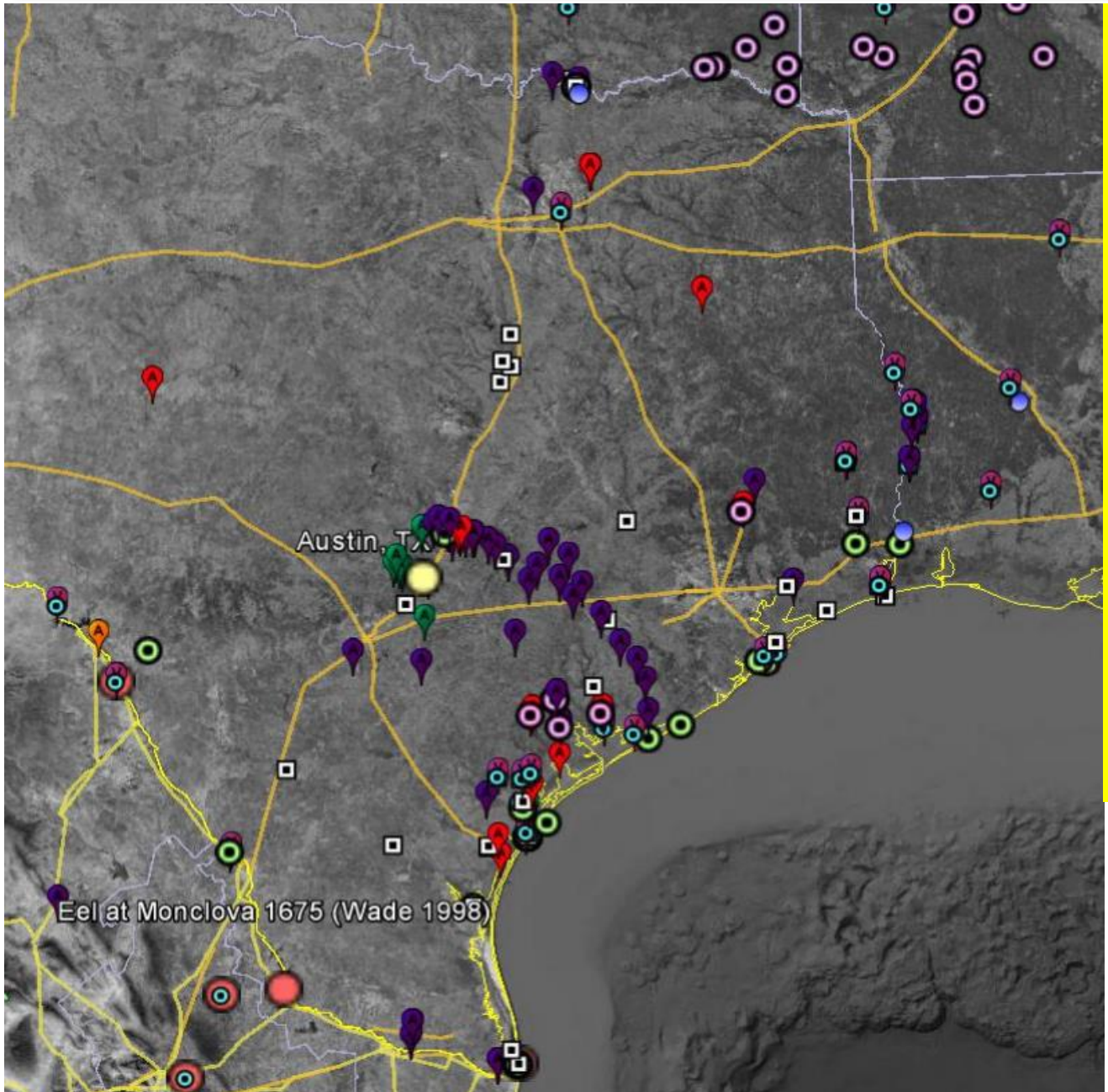

Quick, but diverse, data mining produced a much better baseline of eel occurrences in TX rivers. At least for TX, overlap among datasets was minimal and every dataset had valuable, unique records.

And, we can now explore the temporal dimension of these occurrences

TX eels over time (FoTX website & FoTX non-vouchered)

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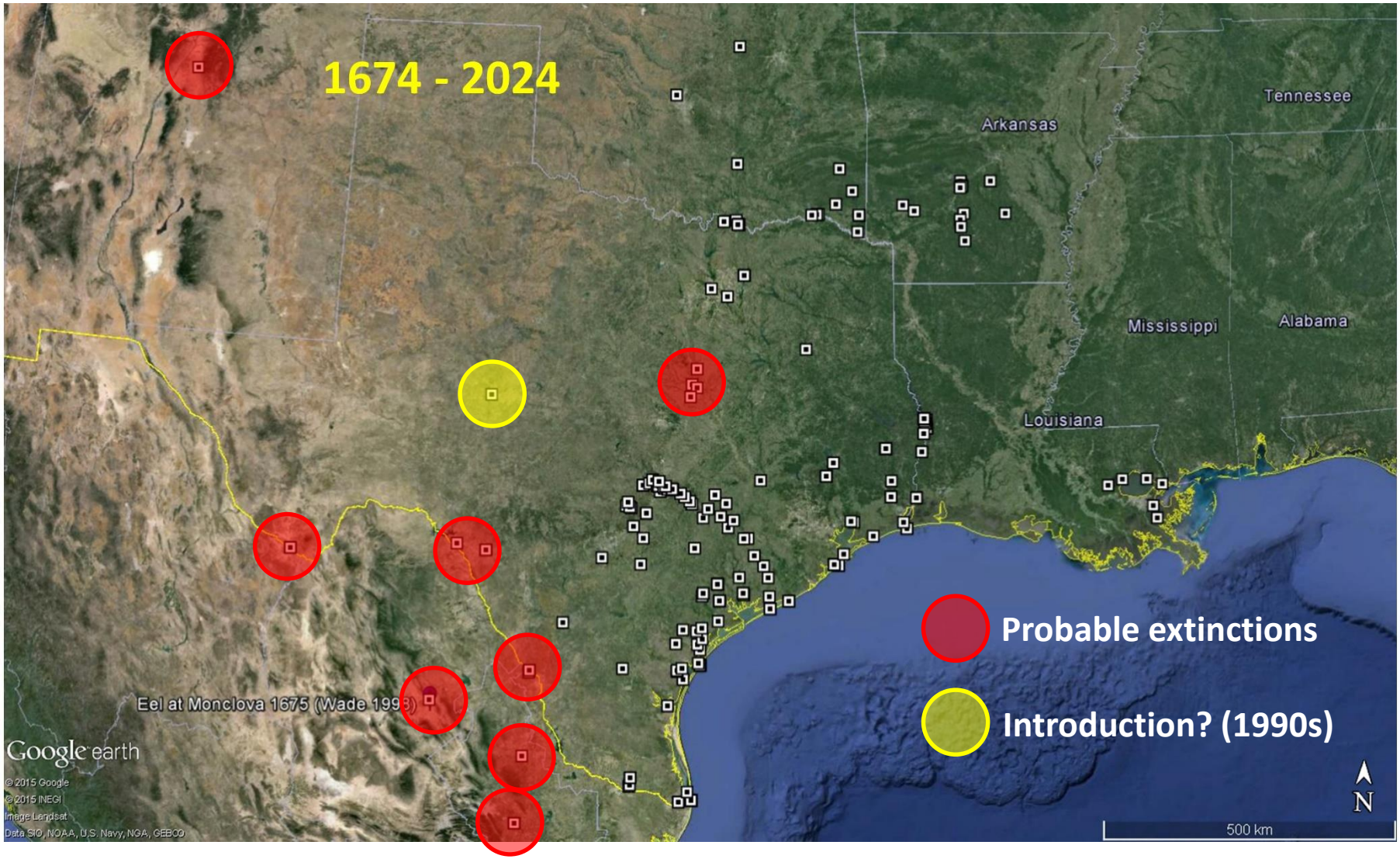
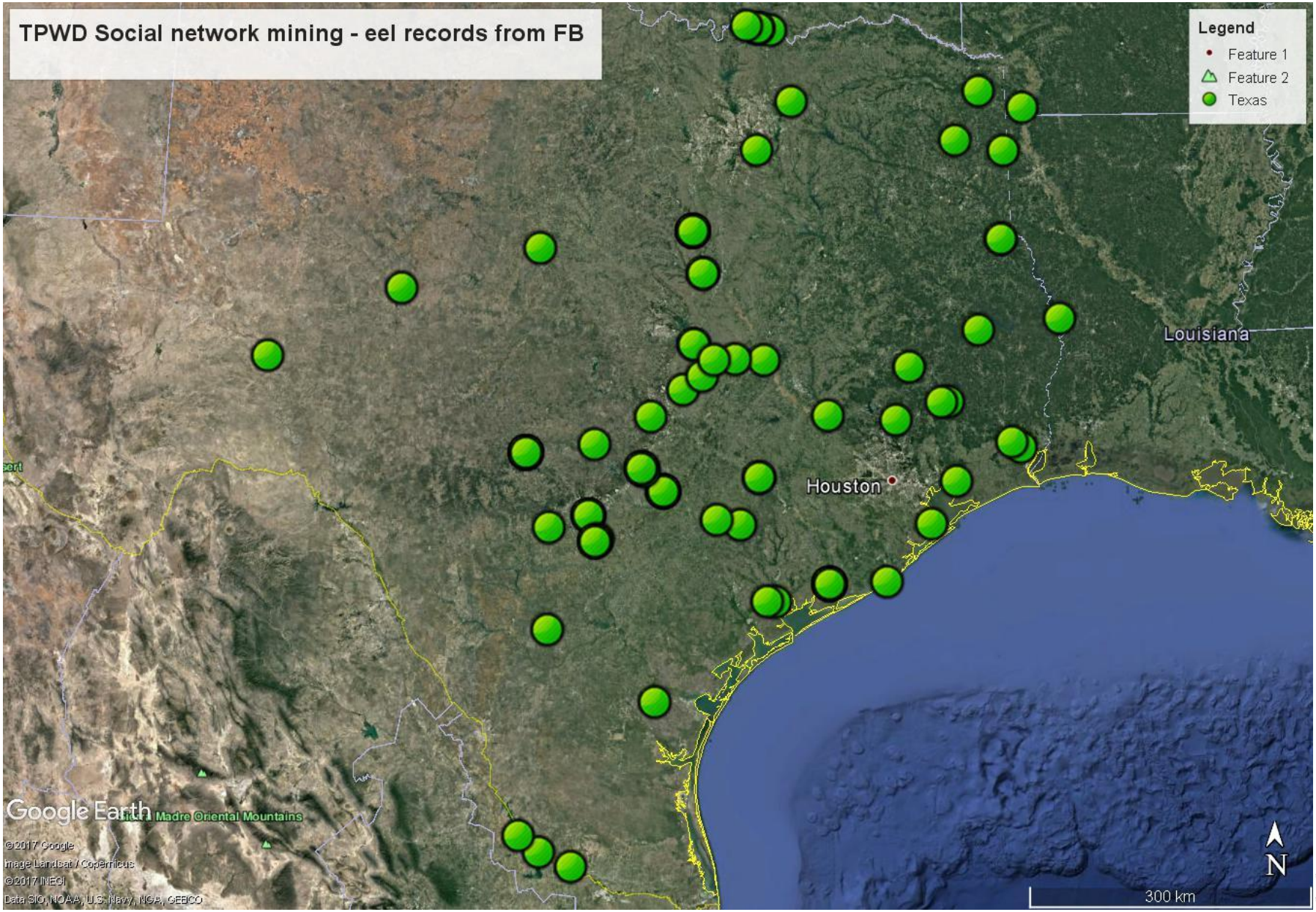


TPWD FACEBOOK MINING

Texas Natural History Collection



Yellow eels may be facultatively catadromous

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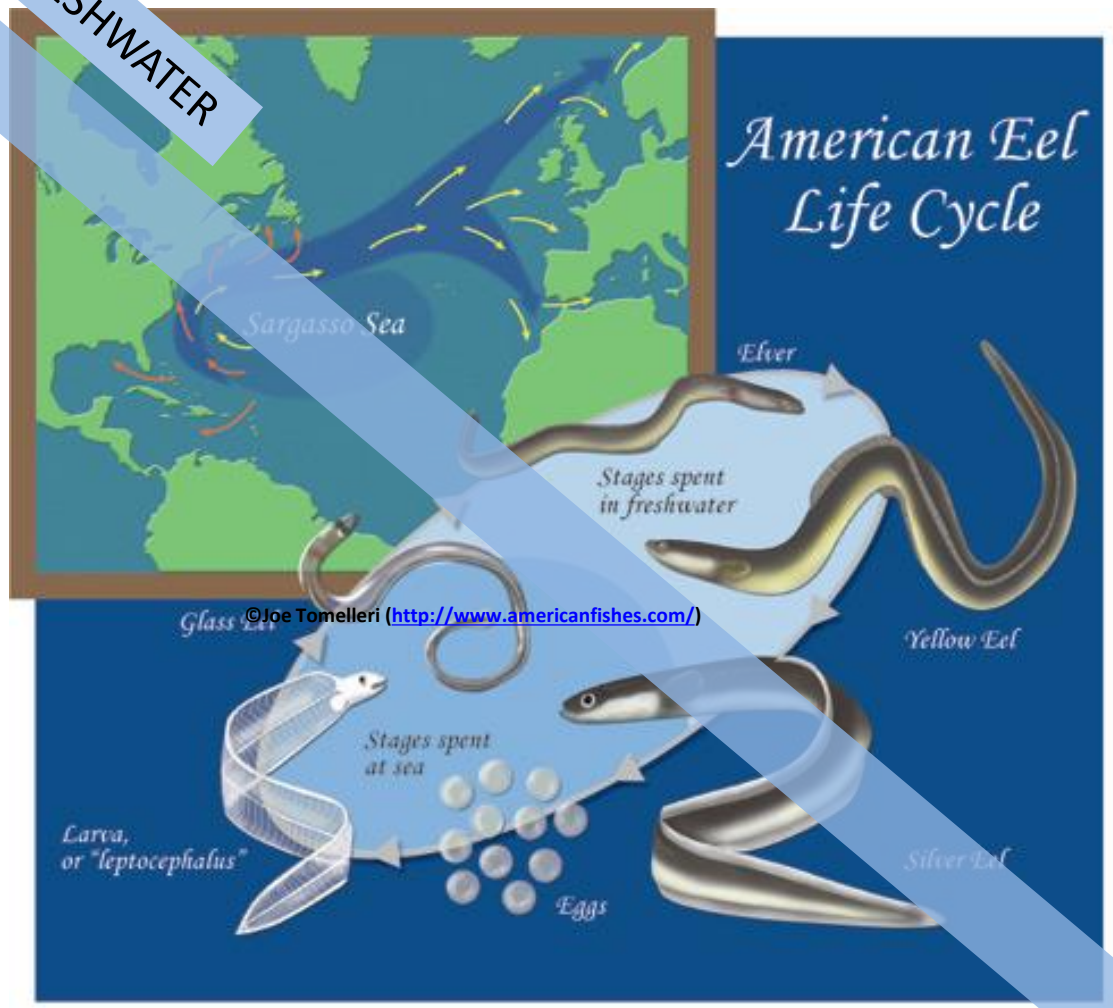
MARINE



©Joe Tomelleri (http://www.americanfishes.com/)

http://www.naturalhistoryillustration.com/website%20images/American%20Eel.html
(*Natural History* Magazine, Nov. 2009

Almost all of those dots in rivers draining to the Gulf of Mexico represent yellow phase eels.

That makes sense because they live for 5-20 years in freshwater.

Glass eels are an integral part of monitoring populations on the east coast. They have never been seen (by biologists anyway) in Texas rivers.

How can that be?

Eel data mining results – ALL COMBINED

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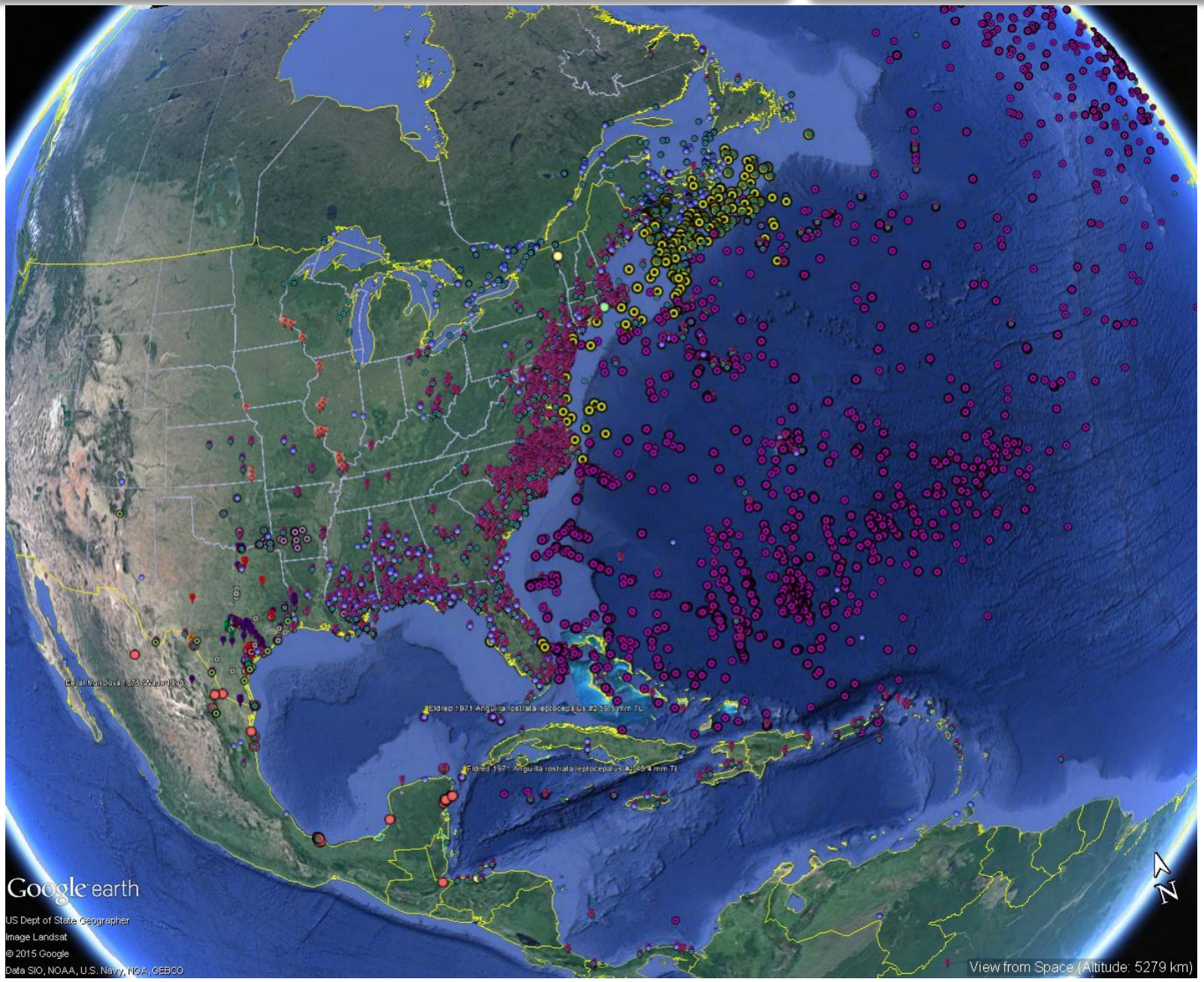


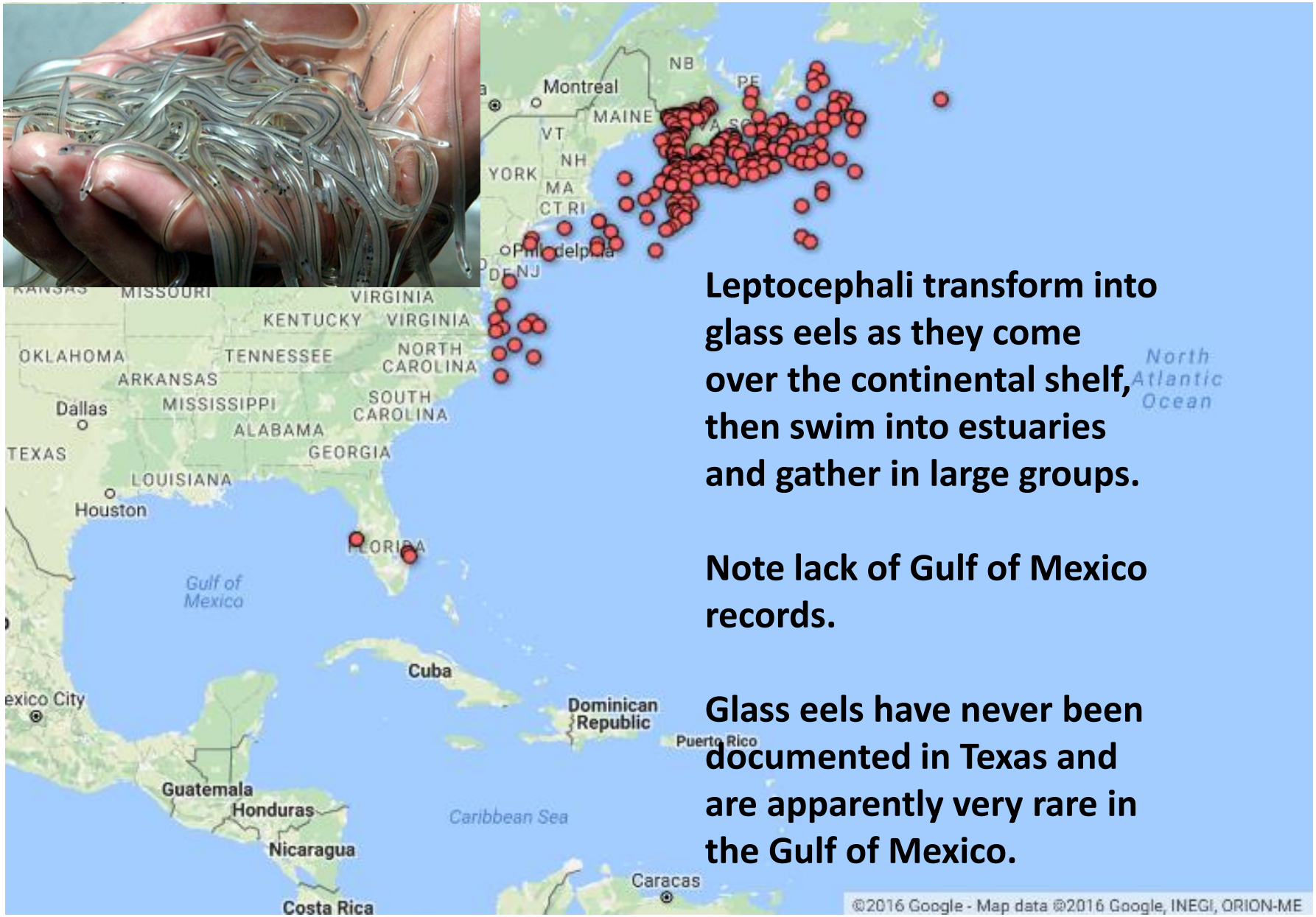
Leptocephali records (ICES)

Texas Natural History Collection

Eggs spawned in Sargasso Sea hatch into leptocephali larvae and drift in currents. Note lack of records in Gulf of Mexico

Glass eel records (ICES)

Texas Natural History Collection



Leptocephali transform into glass eels as they come over the continental shelf, then swim into estuaries and gather in large groups.

Note lack of Gulf of Mexico records.

Glass eels have never been documented in Texas and are apparently very rare in the Gulf of Mexico.

How long would it take a leptocepahlus from Sargasso to TX?

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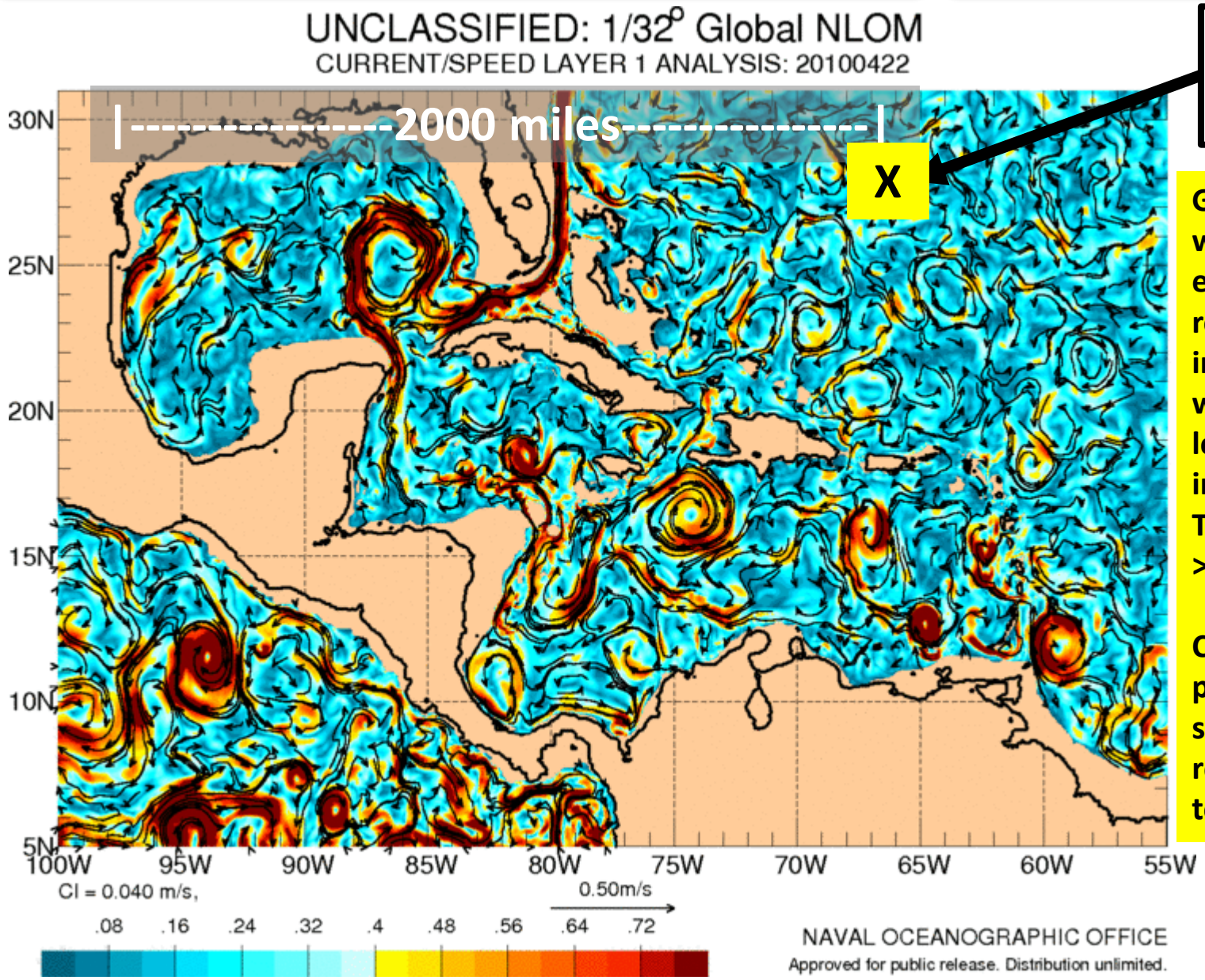

Gulf Current would seem to exclude direct route to TX. Leptos increasing in size were tracked leaving Sargasso into Caribbean. That route to TX is >> 3,000+ miles!

Currents change – periodicity and size of TX recruitment is totally unknown.

Adapted from: http://www.eoearth.org/edit/article/51cbefea7896bb431f69f769//?topic=51cbfc79f702fc2b a812a1b7

New info - life history is more variable

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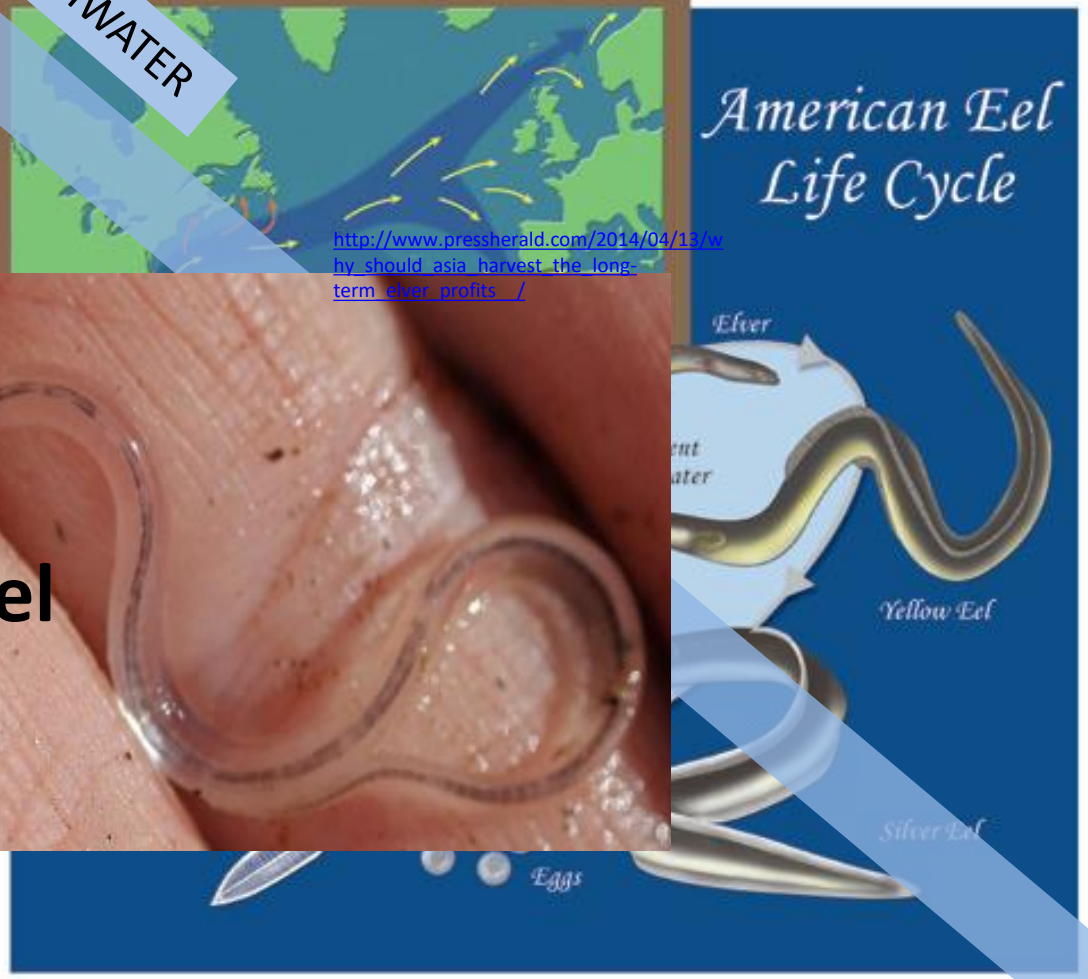
http://www.pressherald.com/2014/04/13/why_should_asia_harvest_the_long-term_elver_profits__/

Glass eel



http://www.naturalhistoryillustration.com/website%20images/American%20Eel.html
(*Natural History* Magazine, Nov. 2009

- Glass eels use tidal transport, density gradients and active swimming to get to river mouths.
- Arrive to Atlantic rivers predictably every spring
- Form groups & head upstream en masse over 4-6 week period.
- Move 3-13 mi / night, increasing pigmentation becoming elvers (4+ inches).

Eels in Texas occur today above some dams and other impediments that most everyone would guess would stop them.

How do they get to those places?

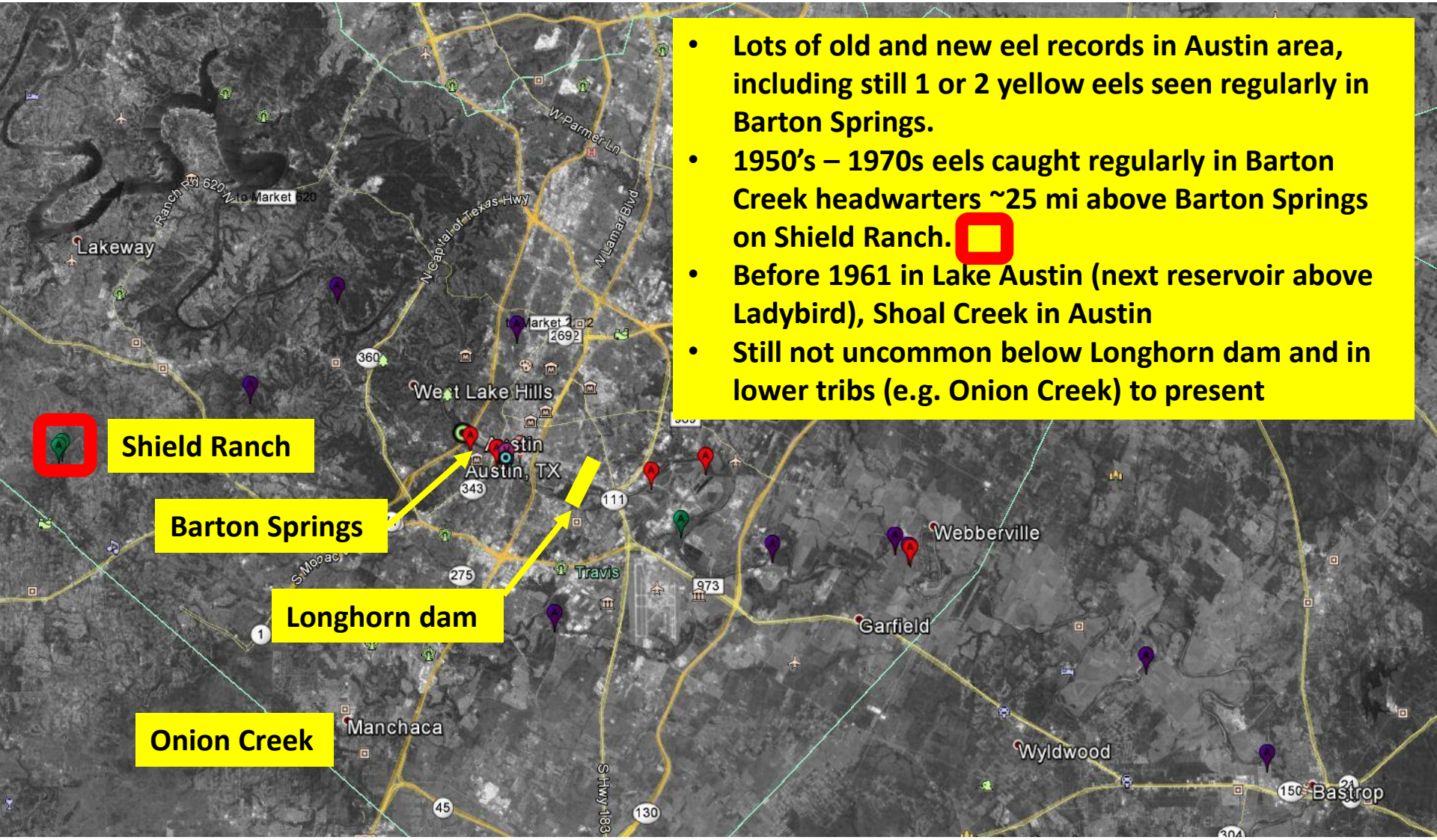
Image from http://www.glooskapandthefrog.org/eel%20gallery.htm

Eels in Texas occur today above what most would guess would stop them – e.g. Barton Springs, and tributary of …

Ladybird (formerly Town) Lake in Austin, impounded by Longhorn Dam, the lowest major dam on the Colorado River

How do they get there? – Colorado above major dam

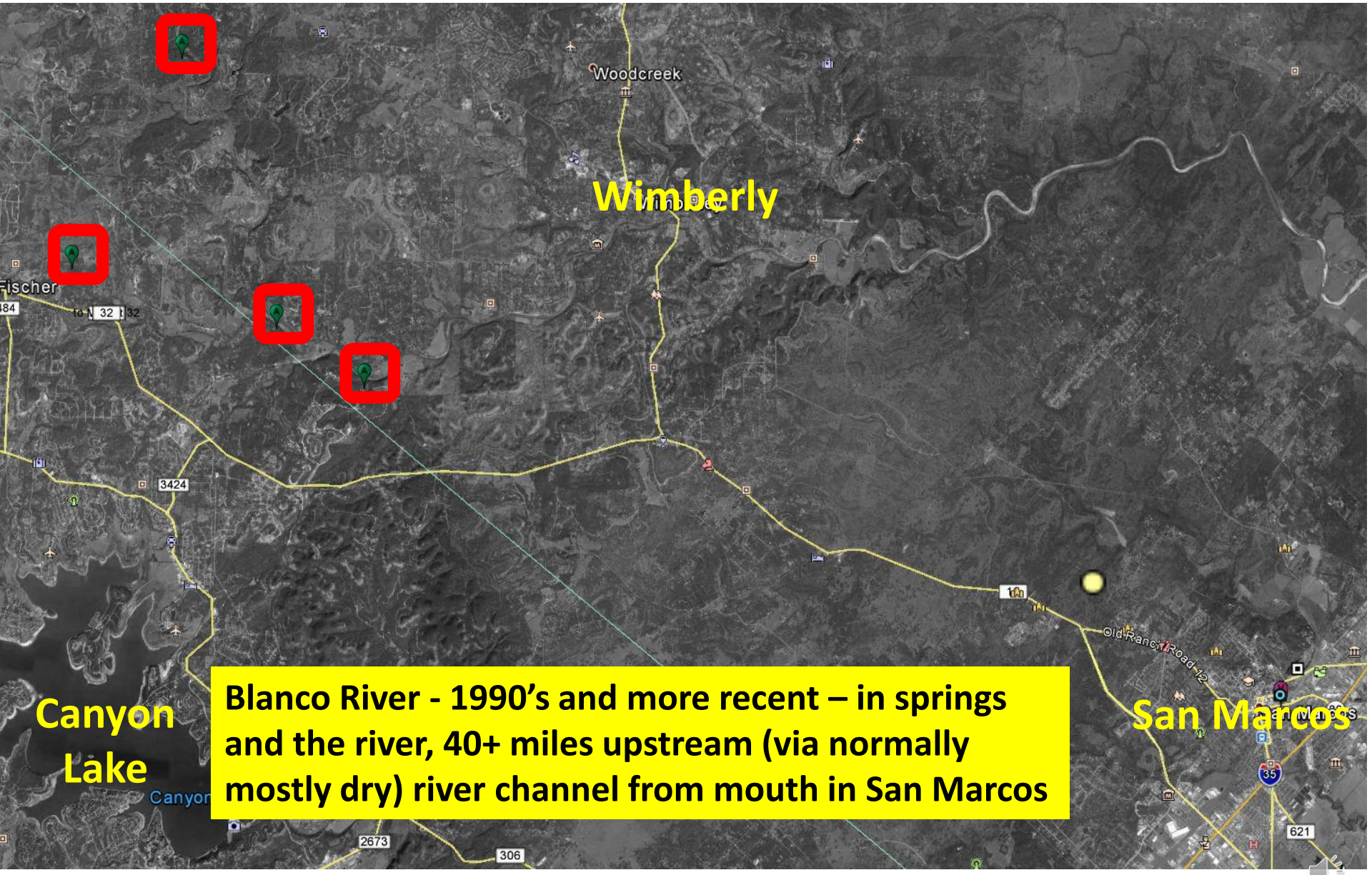
Texas Natural History Collection



- Lots of old and new eel records in Austin area, including still 1 or 2 yellow eels seen regularly in Barton Springs.
- 1950's – 1970s eels caught regularly in Barton Creek headwarters ~25 mi above Barton Springs on Shield Ranch.
- Before 1961 in Lake Austin (next reservoir above Ladybird), Shoal Creek in Austin
- Still not uncommon below Longhorn dam and in lower tribs (e.g. Onion Creek) to present

How do they get there? Blanco River

Texas Natural History Collection



Blanco River - 1990's and more recent – in springs and the river, 40+ miles upstream (via normally mostly dry) river channel from mouth in San Marcos

How do they get there? Glass eels

Texas Natural History Collection

Image from http://americaneel.org/eel-thefts-spur-action/

How do they get there? Elver barrier passage capabilities

Texas Natural History Collection

"Horseshoe Pond dam abutment. Trickles of water leak through the cracks in the granite from the pond above, and the eels follow. It's about a three foot vertical climb to the uppermost seam below the red line. How they make their way through the granite to the pond and river above is a mystery of sorts, but some of them do make it."

Image from http://www.glooskapandthefrog.org/eel%20gallery.htm

How do they get there? elver barrier passage capabilities

Texas Natural History Collection

How do they get there? elver barrier passage capabilities

Texas Natural History Collection

Image from http://www.glooskapandthefrog.org/eel%20gallery.htm

Leaving the river and heading up wet wall

Image from http://www.glooskapandthefrog.org/eel%20gallery.htm


Negotiating a vertical wall
Image from http://www.glooskapandthefrog.org/eel%20gallery.htm

How do they get there? elver barrier passage capabilities

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Taking another route at different discharge

Image from http://www.glooskapandthefrog.org/eel%20gallery.htm

Might baby eels (elvers) get through Longhorn dam?

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Are American Eels endangered?

Canada lists them as endangered, so do several New England states, Canadian provinces, many international conservation groups (eg. IUCN).

U.S. Fish and Wildlife Service recently reviewed the species and in 2015 surprised many by deciding it doesn't merit listing, despite much evidence of declining trends.

What are the threats?

Dams?

Most large dams do block upstream migrations and so exclude eels from much of their historic upstream habitat. Only old (pre-dam) records exist from the upper part of most Texas rivers with major dams. Same in New England.

Recent studies show yellow eels are often facultatively catadromous – go back and forth between marine and freshwaters and some may even live entire life in estuary. So, dams may be less of an impact than once thought.

If eels can get above some dams, how do they get back downstream?

- **Some hydropower dams documented to kill > 90% of adults moving downstream**

Fisheries?

Many years ago local regional eel fisheries worldwide converted to pond culture, but always *totally dependent on wild-caught glass eels*

Pond culture, now mostly in Asia, supplies 90% of all Anguilla production worldwide (280,000 tonnes/yr in 2007)

Source of glass eels for Asian ponds has shifted:

- **1990's Japanese fishery was going downhill due to over-harvest of glass eels. 2011 tsunami destroyed most culture ponds**
- **2000s - Pressure shiftíng to Europe – 2010 EU declared their eel endangered and closed all fisheries.**
- **By 2008 - Pressure shifted to US.**
  - **glass eels 2012 in Maine - $2,600 per pound**

Silver eels leave rivers and go to Sargasso

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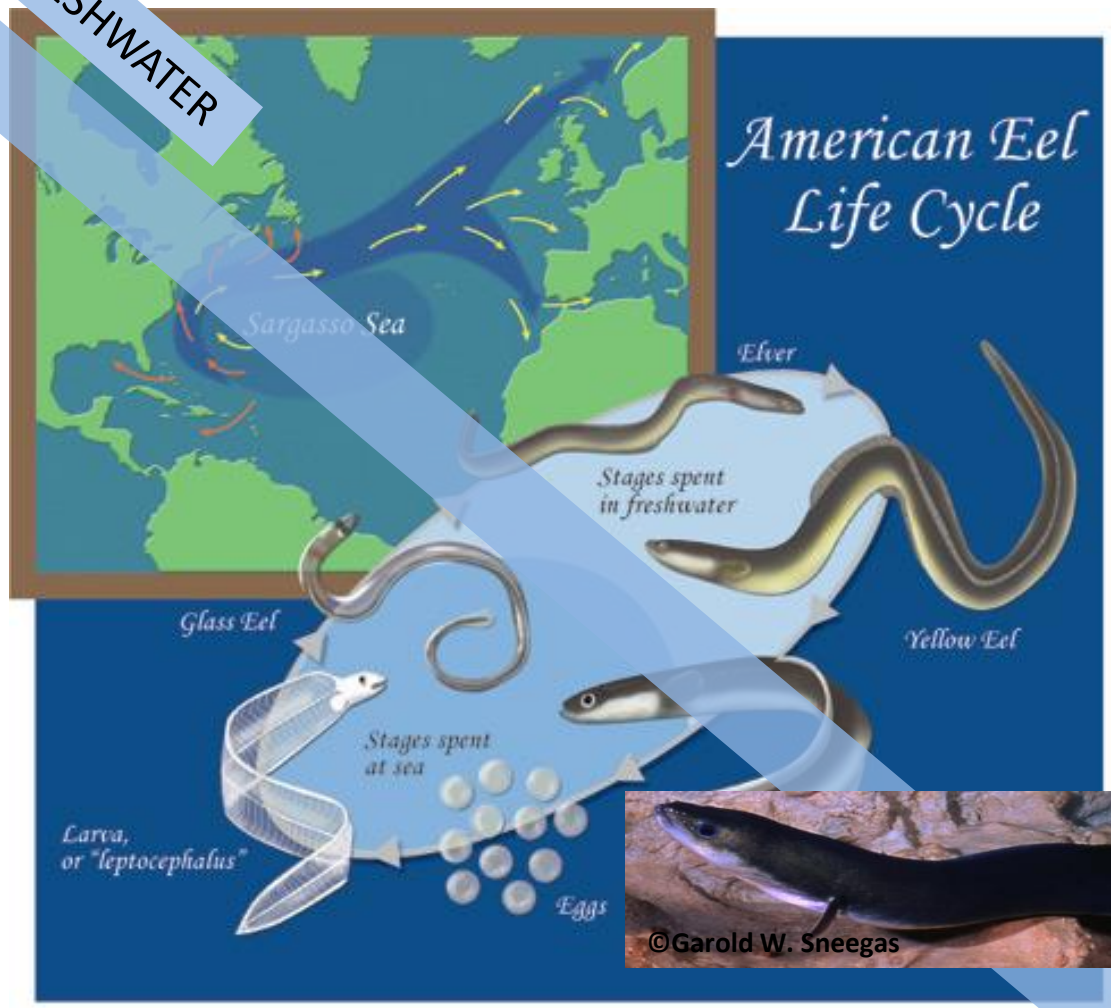


http://www.naturalhistoryillustration.com/website%20images/American%20Eel.html
(*Natural History* Magazine, Nov. 2009

Far inland females are much more prevalent than males. As they mature, eels become silver and transform in other

ways before they head downstream en masse.

Adult eels' trip to Sargasso? New insights

Texas Natural History Collection

Empirical observations of the spawning migration of European eels: The long and dangerous road to the Sargasso Sea

- Fishery data from 20 European rivers
  - most begin oceanic migration between August and December.
- Electronic tagging of 707 outgoing adult eels produced 206 data sets
  - Many migrations ended soon after release because of predation
  - Routes of >80 eels from western mainland Europe to the Azores region, more than 5000 km toward the Sargasso Sea
  - All did vertical migrations, from deeper during day to shallower at night.
  - 3 to 47 km per day
- Spawning in Sargasso likely begins in December and peaks in February.
  - THUS - autumn escapement and the rate of migration are inconsistent with century-long assumption that eels spawn as a single reproductive cohort in the springtime following their escapement.
  - Instead, European eels likely adopt a mixed migratory strategy, with some individuals able to achieve a rapid migration, whereas others arrive only in time for the following spawning season.

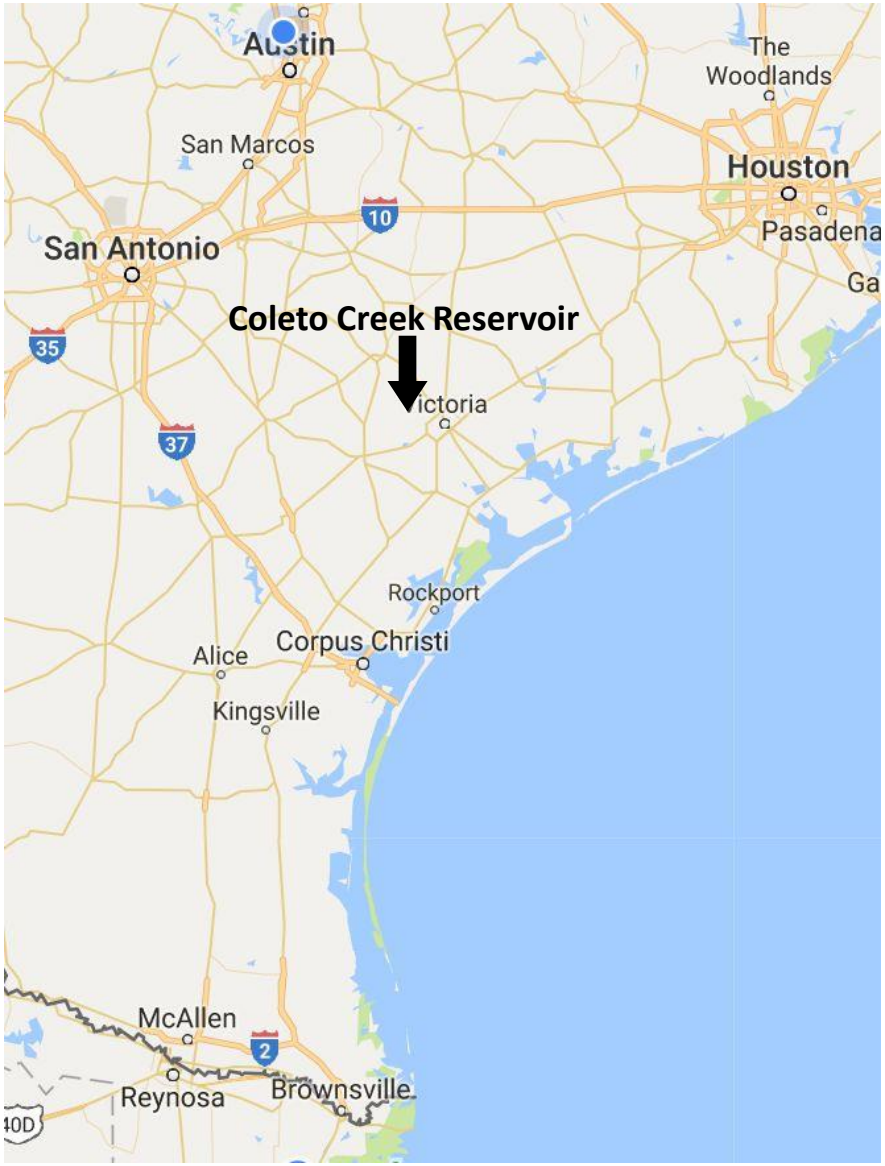
DOI:10.1126/sciadv.1501694

New info - genetics

- Atlantic eels recently ***extensively*** studied
  - ***Panmixia*** is confirmed = no local genetic differentiation
  - But, evidence of genetic response to local environments
    - "In absence of local adaptation, plasticity and spatially varying selection rule"
    - "brackish/saltwater vs freshwater ecotypes have a polygenic basis resulting from intra-generational mechanisms"
    - "within-generation polygenic selection in response to anthropogenic organic and metal contamination".
    - **Essentially, they have a genetic expression "app" for most everything they might encounter wherever they end up.**
  - GoM specimens have *not* been used in genetic studies since the 1970s. Might they be different?
  - Those who did all that work were aware that GoM eels were excluded. They searched for GoM samples, but the literature and readily accessible data led them to believe they were exceedingly rare (**wrong**), so they quickly gave up.

Below Coleto Creek Dam (Guadalupe drainage)

Texas Natural History Collection



May 2016 1 night (afternoon – 2:30 AM) sample - every kind of passive & active net or trap we had + backpack shocker, trot lines, frog gigs

Night shocking + frog gigs, and trot lines most productive for eels:

- **17 specimens**
- **147 – 502 mm**
- **Tissues (muscles/fin), otoliths (Dremel tool extraction – ask me if interested)**
- **Formalin / EtOH preserved**
- **Most from rip-rap**

Coleto Creek (Guadalupe drainage)

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Looks a lot like Longhorn Dam

More places like Longhorn and Coleto Creek dams

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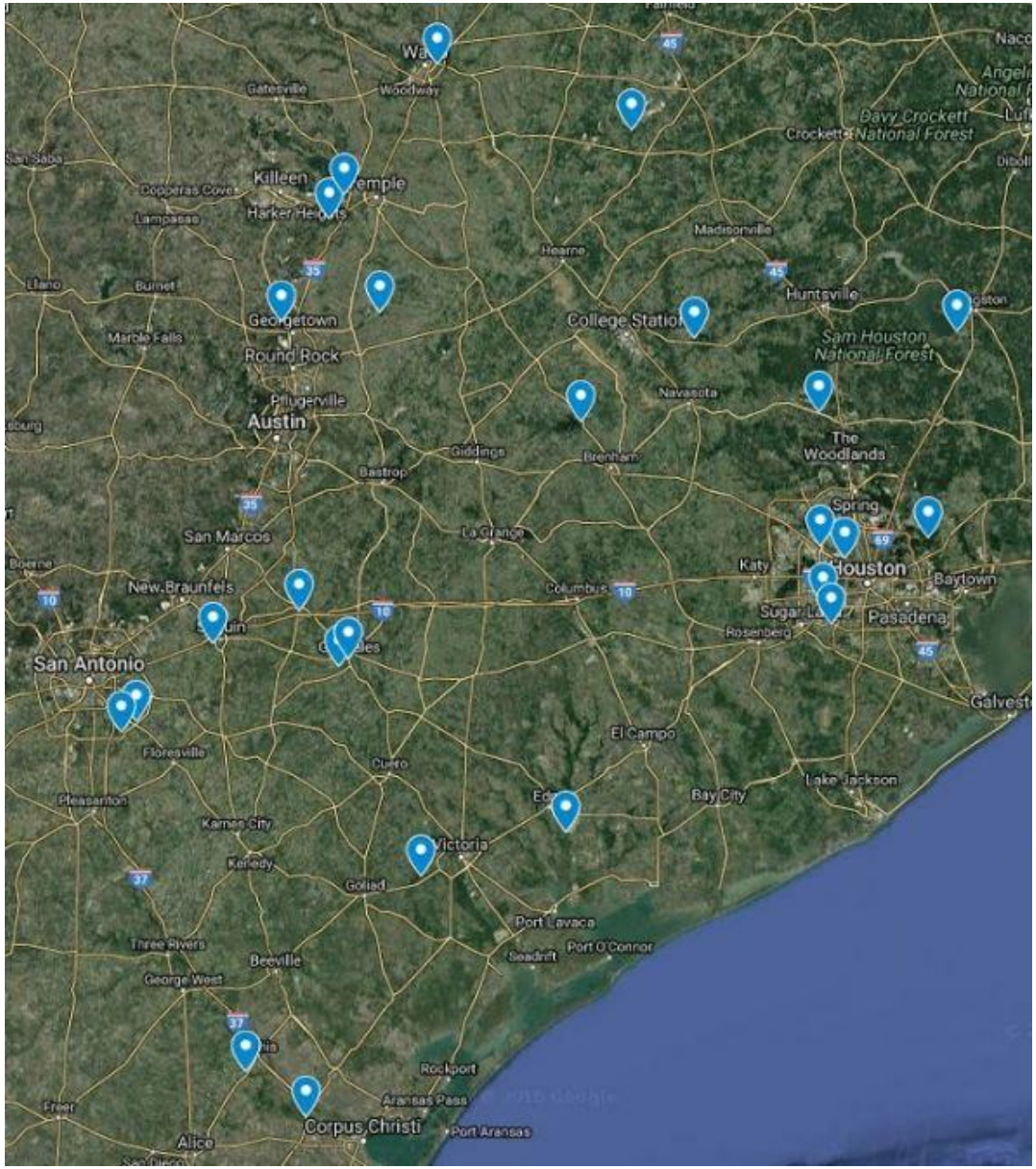

Conclusions

- Eels are probably still in all Texas rivers
- How and when they get to Texas is totally unclear
- We know nothing about recruitment, age structure, genetics of TX eels
- Facultative catadromy may diminish the importance of TX freshwaters to the species
- Some “barriers” are not really barriers to upstream movements (but may be to downstream-bound silver eels)
- Broadly collaborative efforts will be necessary to address most questions
- Publishing and openly sharing all data (including non-vouchered observations) is recommended
- Report all anecdotal (historic and current) observations via our web forms, iNaturalist, email, phone
- If you absolutely must release a captured eel, weigh, measure, take notes and a fin clip, photograph and use iNaturalist (or phone, email) to quickly inform us. See “wanted poster” below.

Leptocephali transport to Texas

- Marine research shedding light on transport of leptocephali to TX is needed
- Problematic sporadic accumulations of Sargassum affect Texas beach area tourism – existing research on predicting those events may be relevant to predicting when eels might arrive at the Texas coast

Otoliths

- Otoliths can provide detailed info on:
  - specimen age (to days in larvae to elver stage)
  - Timing and periodicity of marine/freshwater transition (microchemistry)
- But, no otolith studies on this species in TX

- Glass eels and elvers
  - Systematically monitored in many Atlantic rivers as an excellent and efficient way to quantify eel recruitment to rivers. Methods well developed.
  - January-February in Florida to May in Nova Scotia
  - How is it that we have no records of glass eels from TX? No clue when they come? How many?
  - Sampling for glass/elver eels can be carried out inexpensively. Atlantic river standardized monitoring is largely done by citizen science groups (e.g. http://www.dec.ny.gov/lands/49580.html).

What do we do now?

Texas Natural History Collection

Image from http://www.glooskapandthefrog.org/eel%20gallery.html

Act responsibly

- Now you know where Unagi comes from…
- Provide any observations of eels you might have
- Help us learn about eels in your local river

Eel mops

Texas Natural History Collection

Catching glass eels/elvers is not hard. Each trap took us, 8 high school volunteers, herpetologists and their kids 6-8 person hours to assemble at a total cost of about $120 ea. Let us know if you are willing to help build and/or deploy them (best in lower reaches, especially at barriers, rapids, etc.).

WANTED

Texas Natural History Collection

LOOKING FOR AMERICAN EELS

Please report specimens or observations to Melissa Casarez or Adam Cohen, the Fishes of Texas Project

fishesoftexas@gmail.com

512-475-8171 (Melissa) / 512-471-8845 (Adam)

Maintain specimens alive if possible, or put on ice and give us a call. See links below for more information:

FISHES OF Texas

http://www.fishesoftexas.org

https://sites.cns.utexas.edu/hendricksonlab

iNaturalist

http://www.inaturalist.org/projects/fishes-of-texas

TEXAS PARKS & WILDLIFE